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HUMIDITY PATTERNS AT MIDDLE ELEVATIONS IN THE COASTAL MOUNTAINS OF SOUTHERN CALIFORNIA

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Consider a situation in which a wildfire is burning at middle elevations, say around 2,000 feet above sea level, on the coast side of the mountains of southern California. Relative humidities have been in the 20's or 30's during early afternoon. It is now early evening, and since late afternoon the humidities have been steadily rising, reaching 60 or 70 percent or higher. The fire boss may deduce that the fire will lay down for the night, and that the situation is safe. But is it?

During a fireclimate survey in San Diego County, we have found that the relative humidity at middle elevations frequently shows a sharp drop early in the evening of 30 or 40 percent and sometimes as much as 70 percent. This drop is associated with the onset of downslope and downcanyon winds. The humidity sometimes remains relatively low the rest of the night; at other times, it returns to high values after several hours. The humidity pattern appears to depend upon the height of the top of the layer of moist marine air.

On the survey we installed recorders for wind, temperature, and humidity on both the east and west sides of the Santa Margarita mountains. The survey ran from July 20 through October 1959. One of the west side stations, number 10, was at an elevation near the average height of the base of the marine inversion. This average height is about 1,500 feet in summer along the coast of southern California (1,2) and is presumed to be somewhat higher inland in the afternoon. The top of the layer of moist air may be coincident with the base of the inversion or it may be somewhat higher--in the lower half of the inversion layer. Station 10 was about 9 miles inland at a height of 1,960 feet, and the average height of the Santa Margarita range to the east is about 2,500 feet.

Following are examples of four types of humidity patterns that were observed during the survey. The first is what we usually think of as the "normal" pattern--low humidity in the afternoon and high humidity at night. The second and third are cases in which the humidity fell sharply in the evening. In the second case the humidity returned to high values in the early morning hours and in the third case it did not. The last example is a case in which the humidity remained low both day and night. In these figures the inversion layer is shaded to indicate its probable slope and extent inland in the afternoon.

Case 1.--On July 21, 1959 (fig. 1) the moist layer extended to about 4,000 feet above sea level. Station 10 remained in the moist air both day and night and the relative humidity pattern followed, inversely, the temperature pattern. In this case the winds did not change to downcanyon (easterly) until 0300 P.s.t. However, there were other cases with this type of humidity pattern in which the winds were downcanyon through the night hours.

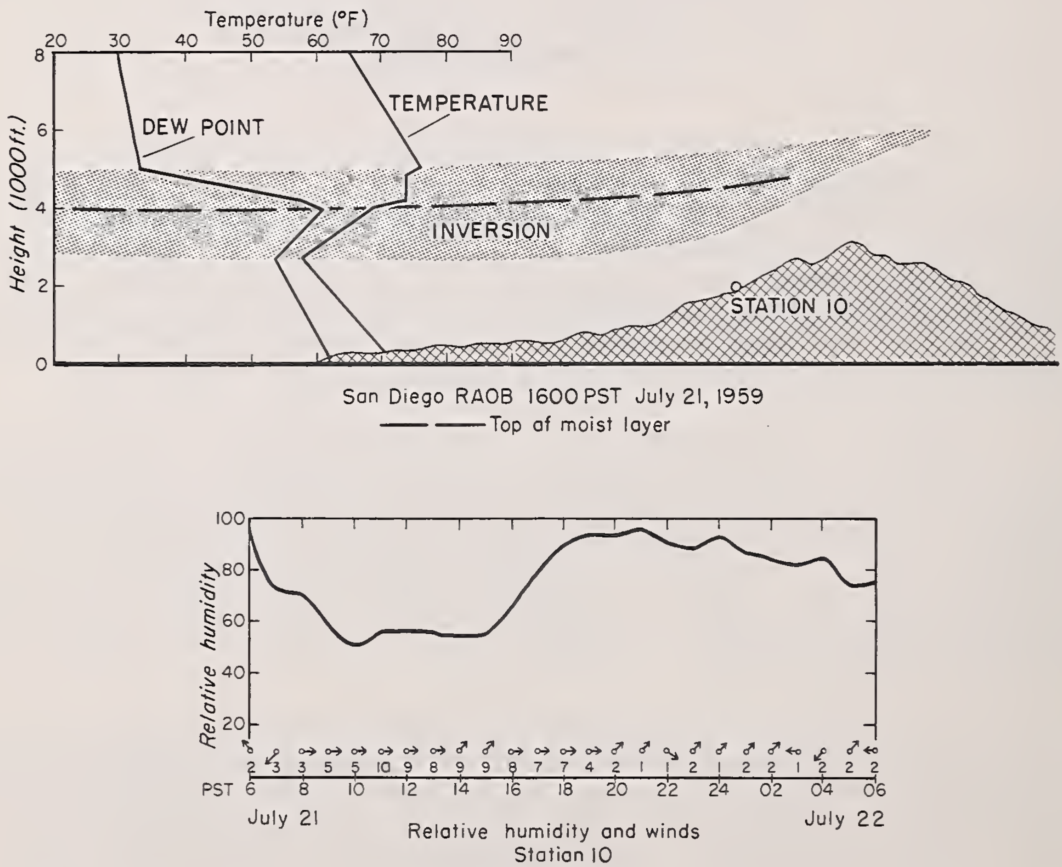

Figure 1.--Relative humidity pattern at Station 10 on a day with a relatively deep marine layer as shown by San Diego raob.

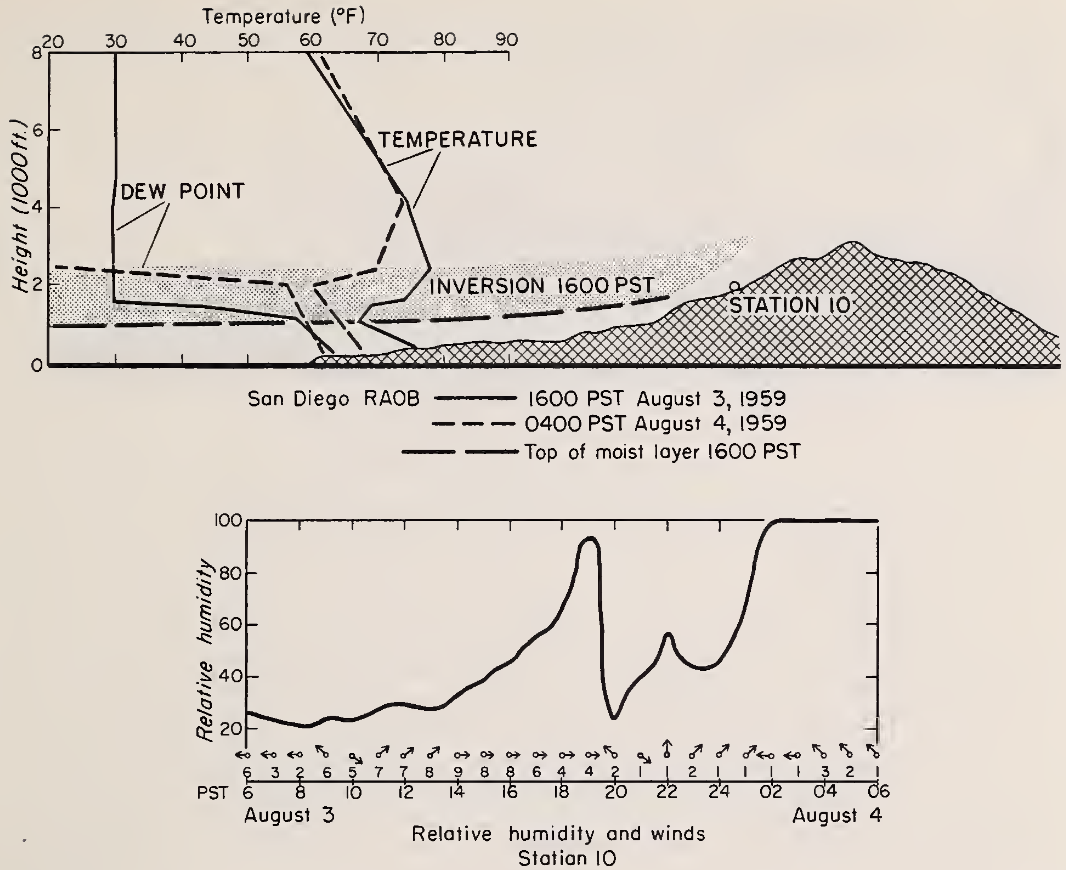

Figure 2.--Relative humidity pattern at Station 10 on a day when the top of the moist marine layer was near the elevation of the station in the afternoon and rose during the night.

Case 2.--On August 3, 1959 (fig. 2) the top of the moist layer was about 1,000 feet at 1600 P.s.t. and increased in depth to 2,000 feet by 0400 P.s.t. the next day. During the late afternoon and early evening hours as the humidity climbed steadily, this station obviously was in the layer of moist air. The humidity dropped sharply when the downcanyon winds began at 2000 P.s.t. and brought dry air from higher levels down to the elevation of this station. Later on as the moist layer deepened this station again got into the moist air and the humidity went up to 100 percent.

Case 3.--Similarly on September 8, 1959 (fig. 3) the top of the moist layer was near the elevation of station 10. The station was in the moist layer during the day and into the early evening. Again when the wind changed to downcanyon and brought dryer air from higher elevations, the humidity dropped abruptly. In this case, however, the depth of the moist layer did not increase significantly during the night and the station remained in the dry air.

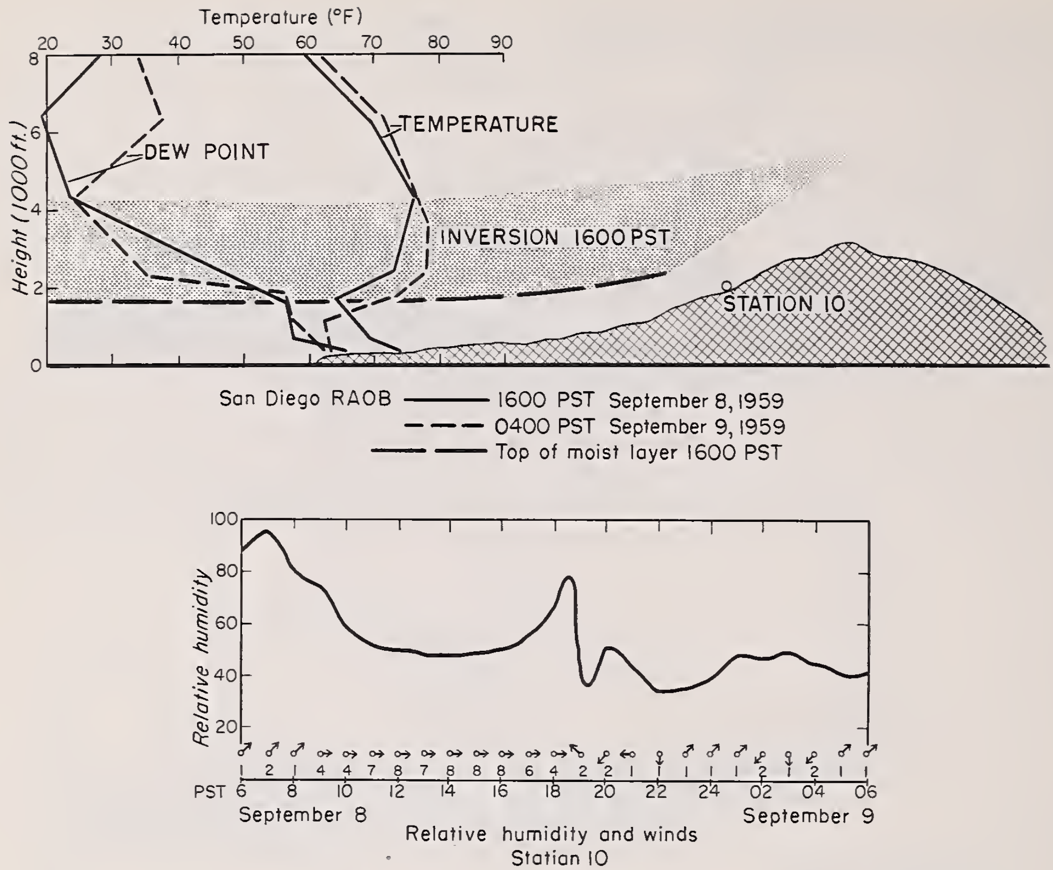

Figure 3.--Relative humidity pattern at Station 10 on a day when the top of the moist marine layer was near the elevation of the station in the afternoon and changed little during the night.

Case 4.--The last example (fig. 4) is a case in which the general wind flow was off-shore and the entire area was bathed in warm, dry continental air. The humidity remained low both day and night. Even though a westerly wind developed during the day, it brought only dry air to the station area. A shallow, low inversion was present along the coast but the air beneath it was very dry.

The humidity patterns shown here occurred at the same station on different days. All of these patterns could occur on the same day in the same area, but at different elevations. Low elevations could be in the moist marine air both day and night and have a humidity pattern similar to figure 1. Middle elevations could have a humidity pattern similar to figure 2 or 3, being in the moist air mass for part of the time and in the dry air mass for part of the time. Higher elevations could remain in the dry air mass throughout the day and night and have a humidity pattern similar to figure 4.

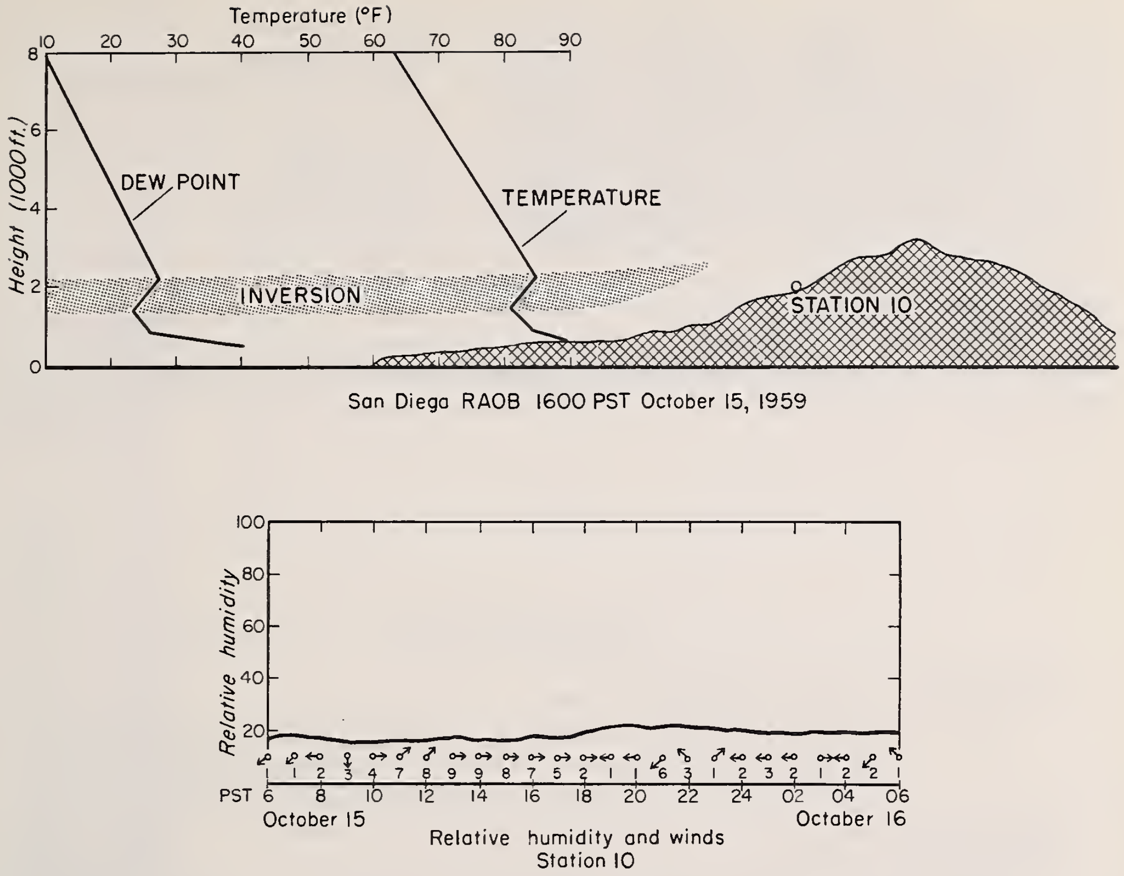

Figure 4.--Relative humidity pattern at Station 10 on a day when the general wind flow was off shore and the station remained in dry air both day and night.

The humidity pattern shown in figure 4 is common at high elevations throughout the State and at lower elevations during Santa Ana and other periods of foehn-type wind. It is expected that the patterns of figures 2 and 3 would be most prevalent on the ocean side of the coastal range but they are not restricted to that side. A survey station located on the east side of the Santa Margarita mountains had similar patterns. Where moist marine air can get into the coastal valleys, with the result that the structure of the lower atmosphere is similar to that shown here, the same patterns can occur.

If a fire boss is directing operations in an area where these different humidity patterns can occur, it is important that he recognize them and take them into consideration in making decisions affecting safety, plans for direct attack, and plans for backfiring. He will have to depend on the fire-weather forecaster for information on the type of pattern expected.

It should be possible for the fire-weather forecaster to indicate in short range, spot forecasts what the humidity pattern will be. The depth of the marine layer can be obtained from a nearby radiosonde observation if one is available. The forecaster will be hampered if none is available, but he can get some clues on the depth of the marine layer from observations, preferably from lookouts, of the top of stratus or haze layers. Ground observations of temperature and humidity made at different elevations in the area will also help. Once the height of the top of the moist layer is determined, the forecaster must consider changes that may take place. These may be indicated by past trends, by changes in the mesoscale pattern, such as the development of a Catalina Eddy, or by changes in the broadscale pattern. He should then be able to foretell whether or not the humidity will drop in the evening and, if it will, at what elevations this type of pattern can be expected.

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